Offshore Multi-Purpose Platform: local electrical network design

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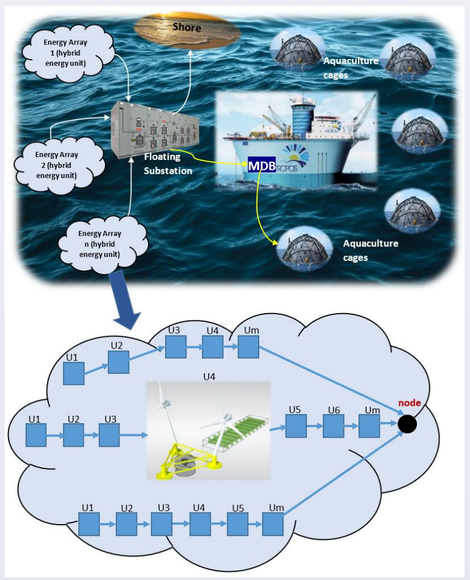
Objectives

- Investigate the feasibility of using dc systems as a promising alternative approach to improve MPP electric infrastructure.
- Develop and design an optimal control system for a marine offshore DC network.

What is a multi-purpose platform?

A Multi-purpose Platform (MPP) is an area of sea or ocean which combines different activities such as aquaculture, tourism, transportation, oil production and energy farms [1]



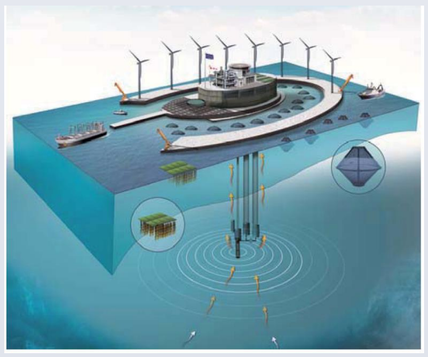
MPP with energy farm

Leisure island

Sustainable Service Hub Island

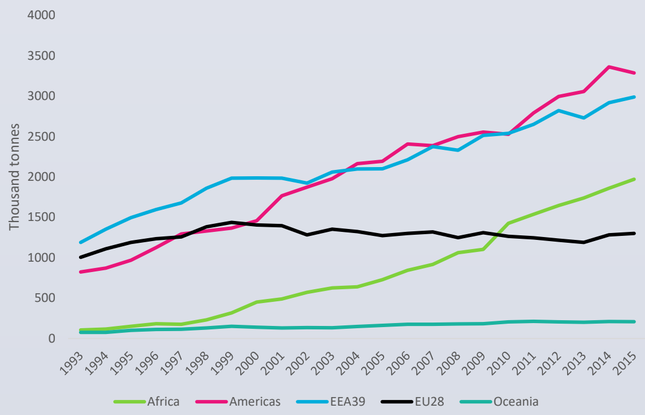
The MPP concept is highly supported by the EU over two large projects:

- The Ocean of Tomorrow: comprises 31 project which ran from 2010 to 2013.
- Horizon 2020: the biggest funded program by EU for research and innovation with 80 billion euro which runs over 7 years from 2014 to 2020



Green and blue island

Why MPP?



The graph shows a gradual rise of aquaculture production in all continents, except Europe which shows almost steady production over 22 years. In spite of gradual increase of market need over this period, the aquaculture production is constant which means huge shortage in supply and large quantities imported.

Global annual aquaculture production by continent [2]

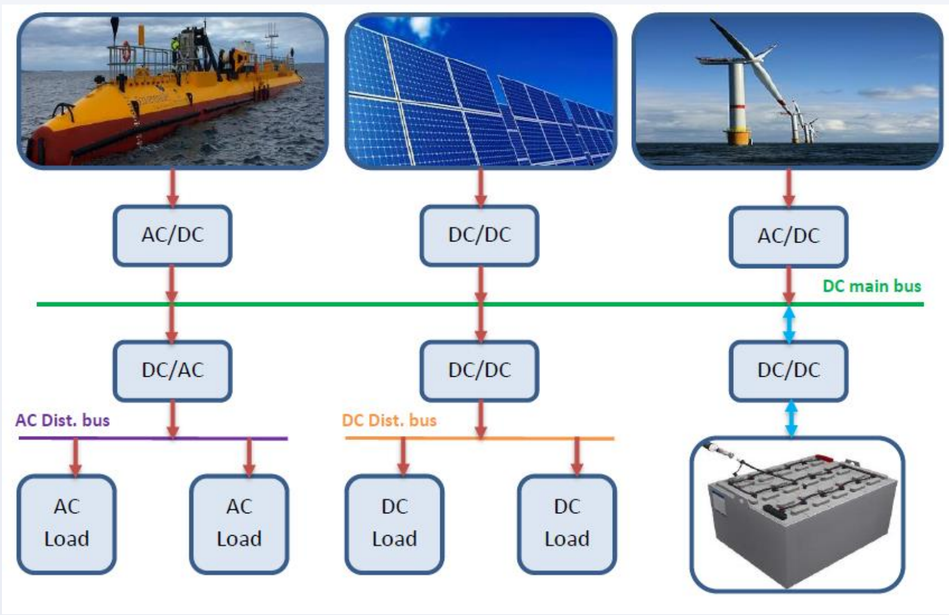
So, MPP would be used for:

- Enhancing aquaculture sector in EU in a sustainable way.
- Supply isolated community and far aquaculture with green energy.
- New horizon for marine tourism and liesure activities.
- Providing fast maintenance for large scale wind farms
- Provide maintenance and services for marine ships offshore.
- Provide facility for fish manufacturing and fish exporting from offshore.

MPP challenges

- Space limitation.
- High costs of system components and installation.
- Isolated grids and no backup option available as platform is far offshore.
- MPP has critical loads such as aquaculture or isolated community.
- There is increased interest in DC grid, however MPP in literature proposed with AC grids.
- Controller robustness and redundancy is highly important for such isolated grids.
- System cost optimization and operation is another challenge on MPP.
- Considering renewable energy only is a big challenge due to intermittent nature of them.

DC grid configuration

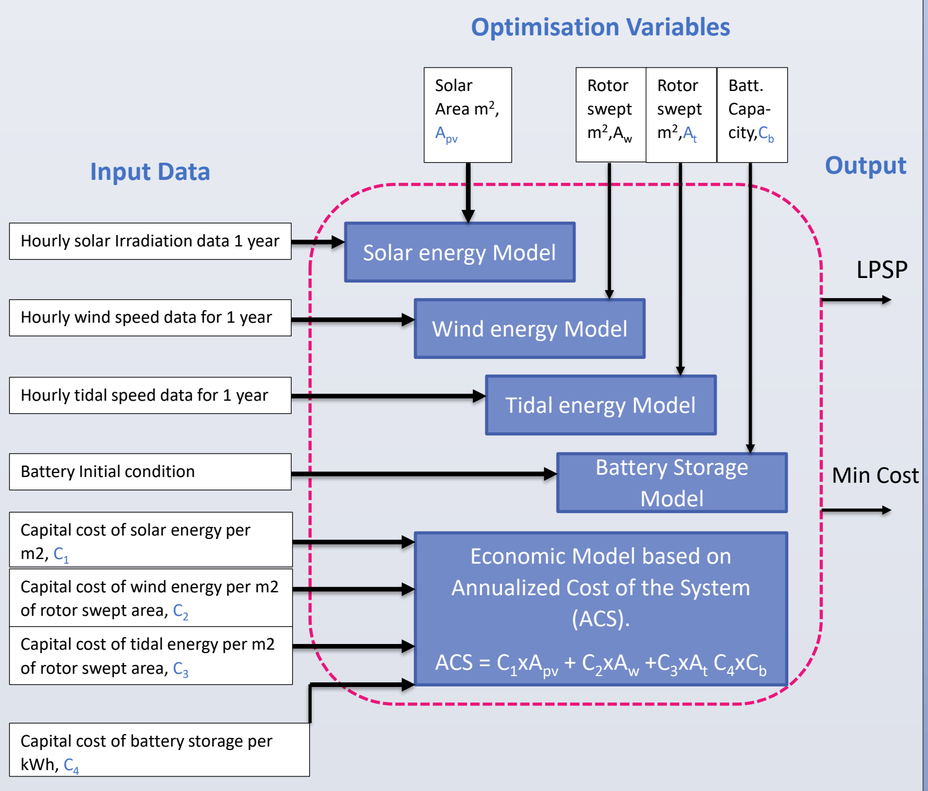


Offshore isolated DC microgrid proposed configuration

The opposite figure shows the proposed configuration for offshore isolated DC microgrid. The sources of energy considered under this study are tidal, wind and solar. No study in literature considered such this combination.

Energy sources optimization

Optimization study is required to allocate the share of each energy source in order to cover the expected load. Optimisation variables of each model is used to achieve certain value for Loss of Power Supply Probability (LPSP) at the minimum system costs. By this the shares of energy resources are estimated considering the input data of each model.



DC grid controller challenges & objectives

- Maintain the DC bus voltage constant with the lowest deviation.
- Proper load power sharing among all converters.
- Improve system and converters efficiency.
- Ensure system robustness and reliability.
- Reduce turbines' maintenance costs and time, and increase turbines lifetime.
- Ensure plug & play, and fault-tolerance capability.
- Extracting maximum power available form sources.
- Controller should be simple and cheap.
- Completely autonomous controller is required for such offshore islanded grids.

Conclusions

The MPP concept is strongly supported by EU with two large projects since 2010. MPP still at early stage of development. No real platforms constructed so far. There are many ideas for MPP platform, but this poster focus only on three of them. Studying the electrical and control system of MPP, in literature, is very rare. Considering islanded DC system based on renewable energy resources is a challenge in terms of the system stability which require novel controller to be achieved.

References

[1] M. Stuiver, K. Soma, P. Koundouri, S. v. d. Burg, A. Gerritsen, T. Harkamp, N. Dalsgaard and F. Zagonari, "The Governance of Multi-Use Platforms at Sea for Energy Production and Aquaculture: Challenges for Policy Makers in European Seas," *Sustainability* , 2016

[2] https://www.eea.europa.eu/data-and-maps/daviz/global-annual-production-by-continent#tab-chart_1

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